Appendix C

Detailed Analysis of Alternatives

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Table C-1. Detailed analysis of alternatives.

Evaluation Criterion and Analysis Factors	Alternative #1 No Action	Alternative #2 Surface Barrier	Alternative #3 In Situ Grouting	Alternative #4 In Situ Vitrification	Alternative #5 Retrieval, Treatment, and Disposal
Overall Protection of Human Health and the Environment					
Will risk be at acceptable levels?	No. No action is conducted at the site; therefore, risks will remain at current levels.	Yes. Based upon preliminary risk modeling, it is predicted that site risks associated with waste and contaminated soil within the SDA will be reduced to acceptable levels. However, combined risks, including impacts from postulated contaminants previously released to the underlying vadose zone, result in groundwater levels that exceed threshold carcinogenic and noncarcinogenic criteria.	Yes. Based upon preliminary risk modeling, it is predicted that site risks associated with the waste and contaminated soil within the SDA will be reduced to acceptable levels. However, combined risks, including impacts from postulated contaminants previously released to the underlying vadose zone, result in groundwater levels that exceed threshold carcinogenic and noncarcinogenic criteria.	Yes. Based upon preliminary risk modeling, it is predicted that site risks associated with the waste and contaminated soil within the SDA will be reduced to acceptable levels. However, combined risks, including impacts from postulated contaminants previously released to the underlying vadose zone, result in groundwater levels that exceed threshold carcinogenic and noncarcinogenic criteria.	Yes. Based upon preliminary risk modeling it is predicted that site risks associated with the waste and contaminated soil within the SDA will be reduced to acceptable levels. However, combined risks, including impacts from postulated contaminants previously released to the underlying vadose zone, result in groundwater levels that exceed threshold carcinogenic and noncarcinogenic criteria.
Timeframe to achieve acceptable levels?	Acceptable levels are not met with this alternative.	It is predicted that the surface barrier (Phase 1) and waste zone-specific in situ treatments can be completed within 11 years following the ROD signature.	It is predicted that in situ treatment with ISG can be completed and the surface barrier constructed within 13 years following the ROD signature.	It is predicted that in situ treatment with ISV can be completed and the surface barrier constructed within 24 years following the ROD signature.	It is predicted that the waste can be retrieved and the surface barrier constructed within 31 years following the ROD signature.
Will the alternative pose any unacceptable short-term or cross-media impacts?	No. No action is conducted at the site; therefore. risks will remain at current levels.	No. Minimal intrusive work. Potential short-term risks can be addressed through proper engineering controls and administrative management.	No. Technology extensively researched for SDA application. Potential short-term risks can be addressed through proper engineering controls and administrative management.	Uncertain. Worker protection and potential contaminant migration concerns (air emissions/organic recondensation in subsurface) need to be further researched.	Uncertain. Worker protection and potential contaminant migration concerns (air emissions) need to be further researched.
Will the alternative impact natural resources?	No. No action is conducted at the site; therefore, risks will remain at current levels.	Natural resources will not be impacted, as the site area is currently disturbed. Potential impacts are associated with the use of off-Site borrow sources and the infringement on adjacent areas for cap construction and staging. Potential for fugitive dusts during implementation can be managed.	Natural resources will not be impacted, as the site area is currently disturbed. Potential impacts are associated with the use of off-Site borrow sources and the infringement on adjacent areas for cap construction and staging. Potential for fugitive dusts during implementation can be managed.	Natural resources will not be impacted, as the site area is currently disturbed. Potential impacts are associated with the use of off-Site borrow sources and the infringement on adjacent areas for cap construction and staging. Potential for fugitive dusts during implementation can be managed.	Natural resources will not be impacted, as the site area is currently disturbed. Potential impacts are associated with the use of off-Site borrow sources and the infringement on adjacent areas for cap construction and staging. Potential for fugitive dusts during implementation can be managed.
What restoration actions may be necessary?	None	None are anticipated with the exception of borrow site, staging area, and haul road restoration.	None are anticipated with the exception of borrow site, staging area, and haul road restoration.	None are anticipated with the exception of borrow site, staging area, and haul road restoration.	None are anticipated with the exception of borrow site, staging area, and haul road restoration.
Will residual contamination (following remediation) be a potential problem?	Yes. Site contamination is not altered by this alternative.	No. However, waste remains untreated on-Site and will require commitment to a long-term maintenance program.	No. It is predicted that risks will be within an acceptable range. However, long-term stability of grout must be verified.	No. It is predicted that risks will be within an acceptable range. Stable long-term matrix.	No. It is predicted that risks will be within an acceptable range.
Compliance with ARARs					
Are chemical-specific ARARs met?	No. Chemical-specific ARARs are not met as the alternative does not meet the RAOs.	Yes. Evaluations indicate that groundwater standards will be met, excluding the vadose zone contribution.	Yes. Evaluations indicate that groundwater standards will be met, excluding the vadose zone contribution.	Yes. Evaluations indicate that groundwater standards will be met, excluding the vadose zone contribution. Uncertainties regarding potential air emissions will require further evaluations during design.	Yes. Evaluations indicate that groundwater standards will be met, excluding the vadose zone contribution. Uncertainties regarding potential air emissions will require further evaluations during design.

Table C-1. (continued).

Evaluation Criterion and Analysis Factors	Alternative #1 No Action	Alternative #2 Surface Barrier	Alternative #3 In Situ Grouting	Alternative #4 In Situ Vitrification	Alternative #5 Retrieval, Treatment, and Disposal
Are location-specific ARARs met?	Yes. No areas are disturbed or impacted.	Yes. Alternative can be designed to achieve identified requirements.	Yes. Alternative can be designed to achieve identified requirements.	Yes. Alternative can be designed to achieve identified requirements.	Yes. Alternative can be designed to achieve identified requirements.
Are action-specific ARARs met?	Not applicable as no actions are conducted.	Yes. All actions can be designed and implemented consistent with identified requirements.	Yes. All actions can be designed and implemented consistent with identified requirements.	Yes. All actions can be designed and implemented consistent with identified requirements. Uncertainties regarding the alternative's ability to meet air emissions standards will require further evaluation during design to ensure compliance.	Yes. All actions can be designed and implemented consistent with identified requirements.
Long-Term Effectiveness and Permanence					
Magnitude of residual risks					
What is the magnitude of the remaining risks?	Site risks as defined in the IRA will continue.	Implementation of this alternative will be sufficient to reduce risk levels associated with future releases from the source term to below 1E-04 and HI to less than 1, excluding the vadose zone contribution.	Implementation of this alternative will be sufficient to reduce risk levels associated with future releases from the source term to below 1E-04 and HI to less than 1, excluding the vadose zone contribution.	Implementation of this alternative will be sufficient to reduce risk levels associated with future releases from the source term to below 1E-04 and HI to less than 1, excluding the vadose zone contribution.	Implementation of this alternative will be sufficient to reduce risk levels associated with future releases from the source term to below 1E-04 and HI to less than 1, excluding the vadose zone contribution.
What remaining sources of risk can be identified?	Untreated waste remains onsite as a potential source of future risk.	The alternative requires long-term maintenance of cap to mitigate risks associated with untreated waste, which remains onsite.	Stabilized and unstabilized waste will remain onsite. Exposure pathways are expected to be minimal or eliminated.	Stabilized and unstabilized waste will remain onsite. Exposure pathways are expected to be minimal or eliminated.	All TRU waste will be removed from the site. Treated and untreated LLW will remain. However, exposure pathways are expected to be minimal or eliminated.
Will a five-year review be required?	Yes.	Yes.	Yes	Yes.	Yes.
Adequacy and reliability of controls					
What is the likelihood that the technologies will meet required process efficiencies or performance specifications?	Not applicable	High. Established technology. Surface barrier design is currently being researched for implementation at ICDF.	Technology extensively researched by DOE at INEEL for site-specific implementation. Anticipated to be effective in meeting performance objectives.	Uncertain. Effectiveness of technology on variable SDA waste needs to be verified.	Uncertain. Ability to retrieve and treat waste to meet regulatory and/or waste acceptance criteria needs to be verified
What type, degree, and requirements of long-term monitoring are required?	Long-term monitoring will include groundwater, vadose zone, soil, surface water, air, perimeter, and biological monitoring.	Long-term monitoring will be implemented to evaluate the effects of the surface barrier. Program could be reduced in the future based on the results of the five-year reviews.	Long-term monitoring will be implemented to evaluate the effects of the grouting and surface barrier. Program could be reduced in the future based on the results of the five-year reviews.	Long-term monitoring will be implemented to evaluate the effects of the vitrification and surface barrier. Program could be reduced in the future based on the results of the five-year reviews.	Long-term monitoring will be implemented to evaluate the effects of the treatment and surface barrier. Program could be reduced in the future based on the results of the five-year reviews.
What operations and maintenance functions must be performed?	None	General maintenance and periodic repair of the surface barrier are anticipated.	General maintenance and periodic repair of the surface barrier are anticipated.	General maintenance and periodic repair of the surface barrier are anticipated.	General maintenance and periodic repair of the surface barrier are anticipated.
What difficulties and uncertainties may be associated with long-term operations and maintenance?	Not applicable.	No difficulties are anticipated. Subsidence-related damage could affect cap integrity.	No difficulties are anticipated. Long-term integrity of grouted waste needs to be verified.	No difficulties are anticipated.	No difficulties are anticipated.
What is the potential need for replacement of technical components?	Not applicable	Routine inspections and barrier maintenance are expected to keep this potential at a minimum.	Routine inspections and barrier maintenance are expected to keep this potential at a minimum.	Routine inspections and barrier maintenance are expected to keep this potential at a minimum.	Routine inspections and barrier maintenance are expected to keep this potential at a minimum.

Table C-1. (continued).

Evaluation Criterion and Analysis Factors	Alternative #1 No Action	Alternative #2 Surface Barrier	Alternative #3 In Situ Grouting	Alternative #4 In Situ Vitrification	Alternative #5 Retrieval, Treatment, and Disposal
What is the magnitude of the threats or risks should the remedial action need replacement?	Not applicable.	Replacement of surface barrier can be readily implemented with minimal risk.	The majority of the site waste has been incorporated in a stable grout monolith Additional ISG applications can be implemented with minimal risk.	The majority of the site waste has been incorporated in a stable glass-like monolith thereby minimizing potential risks, which could affect future remedial action requirements at the site.	The majority of the site waste has been removed or treated for hazardous constituents, thereby minimizing potential risks.
What is the degree of confidence that controls can adequately handle potential problems?	Not applicable.	Long-term monitoring and maintenance will adequately handle potential problems.	Long-term monitoring and maintenance will adequately handle potential problems.	Long-term monitoring and maintenance will adequately handle potential problems.	Long-term monitoring and maintenance will adequately handle potential problems.
What are the uncertainties associated with land disposal of residuals and untreated waste?	Not applicable.	Not applicable	Uncertainties are associated with the treatment technologies required for treating the retrieved Pad A waste to regulatory levels (ARARs) or risk-based levels (PRGs).	Uncertainties are associated with the treatment technologies required for ISV of the retrieved Pad A waste to regulatory levels (ARARs) or risk-based levels (PRGs).	Shipments of TRU waste to the WIPP are exempt from specific LDRs. Uncertainties are associated with some of the treatment technologies for treating the remaining waste to regulatory levels (ARARs) or risk-based levels (PRGs) prior to on-Site disposal.
Reduction of Toxicity, Mobility, or Volume through Treatment					
Treatment process and remedy					
Does the treatment process employed address the principal threats?	No. There are no treatment processes.	Partially. The ISG technology is implemented to address the risks associated with the activation/fission products in the SVRs and trenches. The ISTD is implemented to address risks associated with VC waste streams.	Yes. Grouting will be applied to all waste sites that pose a potential risk, including those sites containing TRU contaminants.	Yes. The ISV and ISG will be applied to all waste sites that pose a potential risk.	Yes. Those sites containing TRU contaminants will be retrieved and disposed of off-Site. Retrieved MLLW will be treated for hazardous constituents and disposed of on-Site. Activation/fission products in SVRs and remaining trenches will be stabilized in-place using the ISG technology.
Are there any special requirements for the treatment process?	No. There are no treatment processes.	Yes. Specialized grout mixes could be required to stabilize waste. The ISTD emission controls/treatment system must be designed to address potential variability in waste stream.	Yes. Specialized grout mixes could be required to stabilize waste. The ISTD emission controls/treatment system must be designed to address potential variability in waste stream.	Yes. Pretreatment of waste will be required to reduce potential MEEs. Emission controls/treatment must be designed to address potential variability in waste stream. Specialized grout mixes could be required to stabilize waste.	Yes. Treatment systems for on-Site waste disposal must be designed to address potential variability in waste stream and meet specific WAC/LDR requirements and control contaminant releases. Specialized grout mixes could be required to stabilize waste.

Table C-1. (continued).

Evaluation Criterion and Analysis Factors	Alternative #1 No Action	Alternative #2 Surface Barrier	Alternative #3 In Situ Grouting	Alternative #4 In Situ Vitrification	Alternative #5 Retrieval, Treatment, and Disposal
Amount of hazardous material destroyed or treated					
What portion (mass, volume) of the contaminated material is destroyed?	None. There are no treatment processes.	The only destructive treatment process involves the ISTD technology in the high organic waste stream areas.	For the ISG technology, contaminated material is encapsulated not destroyed. High organic waste streams will be reduced with the application of the ISTD technology.	Organics are destroyed or removed as part of the off-gas during the thermal desorption and vitrification process. Off-gas treatment may either fix or destroy these materials. Other contaminants are stabilized not destroyed.	Organics are destroyed or removed as part of the thermal treatment process for some non-TRU waste that will be disposed of on-Site. Other contaminants are stabilized or moved to a different location but are not destroyed.
What portion (mass, volume) of the contaminated material is treated?	None. There are no treatment processes.	Activation/fission products will be treated in situ with ISG. High organic waste streams will be treated with the ISTD technology.	All waste containing groundwater COCs will be grouted.	All waste containing groundwater COCs will be treated with either ISV or ISG.	All waste containing groundwater COCs will be either retrieved and treated for disposal or treated in place with ISG.
Reduction in toxicity, mobility, or volume					
To what extent is the total mass of toxic contaminants reduced?	None. There are no treatment processes.	Partial. The ISTD will destroy organic COCs in high-concentration waste steam areas. Other contaminants will either remain untreated onsite or stabilized in place using ISG.	Partial. The ISTD will destroy organic COCs in high-concentration waste steam areas. The remaining contaminant mass will be encapsulated in a grouted monolith.	Organic contaminants are either destroyed or removed by the pretreatment (ISTD) or vitrification process.	Organics are destroyed or removed as part of the thermal treatment process for some non-TRU waste that will be disposed of on-Site. Other contaminants are stabilized or moved to a different location but are not destroyed.
To what extent is the mobility of toxic contaminants reduced?	None. There are no treatment processes.	The mobility of the contaminants is reduced by the placement of a low-permeability cap. The encapsulation of the activation/fission products in SVRs and trenches would significantly reduce contaminant mobility in these areas.	Significant reduction in the contaminant mobility is realized as the material is encapsulated using the ISG technology.	Significant reduction in the contaminant mobility is realized as the material is fixed in the vitrified form or stabilized in place by ISG.	Waste/soil containing groundwater COCs will be removed and all TRU waste will be disposed of off-Site. Remaining material will be treated for its hazardous components and disposed of on-Site.
To what extent is the volume of toxic contaminants reduced?	None. There are no treatment processes.	Only the volume of organic contaminants in the high-concentration waste streams is reduced.	Only the volume of organic contaminants in the high-concentration waste streams is reduced.	Organic contaminants will be either destroyed or removed through the ISV/ISTD process.	Organic contaminants will be either destroyed or removed through the ex situ treatment process.
Irreversibility of the treatment					
To what extent are the effects of the treatment irreversible?	Not applicable to this alternative. There are no treatment processes.	The ISTD will destroy the organic COCs within high-concentration areas. The ISG is applied only to activation/fission product waste located in trenches and SVRs. The grouted material is extremely durable and not easily reversed.	The ISTD will destroy the organic COCs within high-concentration areas. If properly designed and implemented, the grouted monolith resulting from the ISG process is extremely durable and not easily reversed.	Organic COCs within waste and soil will be destroyed. The vitrified material is extremely durable and is not reversible.	The ex situ treatment for hazardous organic constituents before on-Site disposal will not be reversible.
Type and quantity of treatment residuals					
What residuals remain?	Not applicable to this alternative. There are no treatment processes.	The ISG technology will be applied to the activation/fission product waste	None. No treatment residuals are associated with the ISG technology requiring disposal.	As this is an in situ treatment application, all materials remain at the site.	All treatment residuals will remain on-Site. The TRU waste will be transported off-Site for disposal.
What are their quantities and characteristics?	Not applicable	Waste in the SVRs and selected trench areas will be encapsulated in grout monolith.	As this is an in situ treatment application, all quantities remain at the site.	As this is an in situ treatment application, all quantities remain at the site.	All retrieved non-TRU waste will be treated and placed in an on-Site engineered facility.

Table C-1. (continued).

Evaluation Criterion and Analysis Factors	Alternative #1 No Action	Alternative #2 Surface Barrier	Alternative #3 In Situ Grouting	Alternative #4 In Situ Vitrification	Alternative #5 Retrieval, Treatment, and Disposal
What risks do treatment residuals pose?	Not applicable.	Limited. Contaminants are encapsulated in the grout and a barrier is placed over the surface to prevent intrusion.	Limited. Contaminants are encapsulated in the grout and a barrier is placed over the surface to prevent intrusion.	Limited. Contaminants are fixed in the vitrified melt and a barrier is placed over the surface to prevent intrusion.	Limited. All materials will be treated for their hazardous components before to on-Site disposal. In addition, a barrier is placed over the surface to prevent intrusion.
Statutory preference for treatment as a principal element					
Are principal threats within the scope of the action?	No. Principal threat areas are not addressed in this alternative.	Yes. Principal threat areas are addressed in this alternative.	Yes. Principal threat areas are addressed in this alternative.	Yes. Principal threat areas are addressed in this alternative.	Yes. Principal threat areas are addressed in this alternative.
Is treatment used to reduce inherent hazards posed by principal threats at the site?	No. There are no treatment processes.	Yes. The ISG is used to treat the activation/fission product waste in SVRs and trenches. The ISTD is used to destroy organic COCs in high-concentration waste streams.	Yes. Groundwater COCs will be destroyed or encapsulated in a stable grout monolith.	Yes. Groundwater COCs will be treated either through ISTD/ISV or ISG.	Yes. The COC-bearing waste streams will be retrieved and treated before disposal. The TRU materials will be disposed of off-Site, but will not be treated. The ISG will be used to treat the activation/fission product waste in SVRs and trenches.
Short-Term Effectiveness					
Protection of community during remedial actions					
What are the risks to the community during remedial actions that must be addressed?	None. Implementation of this alternative will pose no additional risks to the community.	Implementation may pose low risk to the community due to potential release of fugitive dust and the use of off-Site borrow sources.	Potential releases of fugitive dust during earthwork operations.	Potential release of fugitive dust during earthwork operations. Additional research required to provide appropriate engineering controls to address potential contaminant release including emissions and MEEs during ISV implementation.	Potential release of fugitive dust during earthwork operations. Off-Site transport of TRU waste is required with potential industrial and radiological hazards to off-Site communities. Additional research is required to provide appropriate engineering controls to address contaminant releases during retrieval/treatment.
How will the risks to the community be addressed and mitigated?	Not applicable.	Developing a stringent traffic control plan would mitigate risks. In addition, appropriate engineering controls and contingency plans will be developed and implemented during the barrier installation. No contaminated material will be exposed during the installation. Community risks are considered to be negligible for this alternative.	Developing a stringent traffic control plan would mitigate risks. In addition, particulate emissions will be controlled using dust-suppression techniques and contaminant releases, if any, will be captured and treated.	Developing a stringent traffic control plan would mitigate risks. In addition, particulate emissions will be controlled using dust-suppression techniques and contaminant releases, if any, will be captured and treated. Properly designed, redundant emission control systems will be implemented for ISTD and ISV technologies. The MEEs during ISV implementation will be minimized through ISTD pretreatment, the placement of a soil cover, and the application of planar ISV.	Developing a stringent traffic control plan would mitigate risks, and particulate emissions will be controlled using dust-suppression techniques. Properly designed, redundant emission control systems will be implemented for double-containment treatment and retrieval buildings.
What risks remain to the community that cannot be readily controlled?	None.	Minimal. Increased traffic will occur at some locations in adjacent off-Site areas.	Minimal. Increased traffic will occur at some locations in adjacent off-Site areas.	Uncertain. Further research is needed to establish implementation requirements for SDA-specific ISV application.	Uncertain. Further research is needed to establish implementation requirements for SDA-specific retrieval action. Traffic would significantly increase off-Site due to waste shipments to WIPP.

Table C-1. (continued).

Evaluation Criterion and Analysis Factors	Alternative #1 No Action	Alternative #2 Surface Barrier	Alternative #3 In Situ Grouting	Alternative #4 In Situ Vitrification	Alternative #5 Retrieval, Treatment, and Disposal
Protection of workers during remedial action					
What are the risks to the workers that must be addressed?	No additional risks to workers.	Potential physical risk to moving equipment. Potential release of fugitive dust during the construction. During Pad A retrieval and ISTD implementation, workers have a potential risk of direct radiation and/or inhalation hazards from waste buried at the site.	Potential physical risk to moving equipment. Potential release of fugitive dust during the construction. During Pad A retrieval, and ISG and ISTD implementation, workers have a potential risk of direct radiation and/or inhalation hazards from waste buried at the site.	Potential physical risk to moving equipment. Potential release of fugitive dust during the construction. During Pad A retrieval, and ISG, ISTD and ISV implementation, workers have a potential risk of direct radiation and/or inhalation hazards from waste buried at the site. Potential MEE hazards during the implementation of ISV.	Potential physical risk to moving equipment. Potential release of fugitive dust during construction. During retrieval and material handling activities, and the implementation of ISG, and ISTD, workers have a potential risk of direct radiation and/or inhalation hazards from waste buried at the site.
How will the risks to the workers be addressed and mitigated?	Not applicable	Risks will be mitigated through training and the use of on-Site safety observers, engineering controls, administrative controls (INEEL health and safety protocols), and PPE (where appropriate). Dust suppression techniques will be used for high-traffic areas. Grouting equipment has been engineered to capture contaminants that could be given off during the operation.	Risks will be mitigated through training and the use of on-Site safety observers, engineering controls, administrative controls (INEEL health and safety protocols), and PPE (where appropriate). Dust-suppression techniques will be used for high-traffic areas. Grouting equipment has been engineered to capture contaminants that could be given off during the operation.	Risks will be mitigated through training and the use of on-Site safety observers, engineering controls, administrative controls (INEEL health and safety protocols), and PPE (where appropriate). Dust-suppression techniques will be used for high-traffic areas. The ISV technologies have been engineered to provide the capture of contaminants that could be given off during the operation. Mitigation of MEEs by pretreating waste with ISTD and by placing 3 m (10 ft) of overburden over the melt area.	Risks will be mitigated through training and the use of on-Site safety observers, engineering controls, administrative controls (INEEL health and safety protocols), and PPE (where appropriate). Dust-suppression techniques will be used for high-traffic areas. Remote equipment will be used, where appropriate, to minimize worker exposure Contaminant control systems will be designed with redundant measures to minimize uncontrolled contaminant releases.
What risks remain to the workers that cannot be readily controlled?	Not applicable	Risks associated with surface barrier construction will be minimal. Risks are associated with Pad A retrieval, and ISTD and ISG implementations will be mitigated through training and the use of on-Site safety observers, engineering controls, administrative controls (INEEL health and safety protocols), and PPE (where appropriate).	Minimal. The ISG application has been researched at INEEL to provide for worker protection. Risks associated with Pad A retrieval and ISTD implementation will be mitigated through training and the use of on-Site safety observers, engineering controls, administrative controls (INEEL health and safety protocols), and PPE (where appropriate).	Uncertain. Further research is needed to establish implementation requirements for SDA-specific ISV application.	Uncertain. Further research is needed to establish implementation requirements for SDA-specific retrieval action.
Environmental Impacts					
What environmental impacts are expected with the construction and implementation of the alternative?	None. No additional risks are posed to the environment.	Cultural resource could be impacted in proposed borrow sites and in areas adjacent to SDA affected by remedial actions. Fugitive dust releases could occur during the borrow material work activities and implementation of the engineered surface barrier, possibly affecting the outlying areas.	Cultural resource could be impacted in proposed borrow sites and in areas adjacent to SDA affected by remedial actions. Fugitive dust releases and potential contaminant releases could occur during implementation.	Cultural resource could be impacted in proposed borrow sites and in areas adjacent to SDA affected by remedial actions. Fugitive dust releases and potential contaminant releases could occur during implementation.	Cultural resource could be impacted in proposed borrow sites and in areas adjacent to SDA affected by remedial actions. Fugitive dust releases and potential contaminant releases could occur during implementation.

Table C-1. (continued).

Evaluation Criterion and Analysis Factors	Alternative #1 No Action	Alternative #2 Surface Barrier	Alternative #3 In Situ Grouting	Alternative #4 In Situ Vitrification	Alternative #5 Retrieval, Treatment, and Disposal
What are the available mitigation measures to be used and what is their reliability to minimize potential impacts?	Not applicable.	Potentially impacted areas will be screened to minimize and mitigate potential damages to cultural resources. Dust-suppression techniques also will be used for high-traffic areas.	Potentially impacted areas will be screened to minimize and mitigate potential damages to cultural resources. Dust-suppression techniques also will be used for high-traffic areas. Engineered controls will be implemented to mitigate the potential release of contaminants.	Potentially impacted areas will be screened to minimize and mitigate potential damages to cultural resources. Dust-suppression techniques also will be used for high-traffic areas. Engineered controls will be implemented to mitigate the potential release of contaminants.	Potentially impacted areas will be screened to minimize and mitigate potential damages to cultural resources. Dust-suppression techniques also will be used for high-traffic areas. Engineered controls will be implemented to mitigate the potential release of contaminants.
What are the impacts that cannot be avoided should the alternative be implemented?	Not applicable.	None known.	None known.	Uncertain. Further research is needed to establish implementation requirements for SDA-specific ISV application.	A significant increase in traffic would occur both on-Site and off-Site.
Time until remedial action objectives are achieved					
How long until protection against the threats being addressed by the specific action is achieved?	Protection is not achieved.	It is predicted that the surface barrier (Phase 1) can be completed within 13 years following the ROD signature.	It is predicted that in situ treatment can be completed and the surface barrier constructed within 14 years following the ROD signature.	It is predicted that in situ treatment can be completed and the surface barrier constructed within 24 years following the ROD signature.	It is predicted that the waste can be retrieved and the surface barrier constructed within 31 years following the ROD signature.
How long until any remaining site threats will be addressed?	Site threats are not addressed.	Not applicable.	Not applicable.	Not applicable.	Not applicable.
How long until RAOs are achieved?	The RAOs are not achieved.	All RAOs are met upon completion of the action.	All RAOs are met upon completion of the action.	All RAOs are met upon completion of the action.	All RAOs are met upon completion of the action.
Implementability					
Technical feasibility					
What difficulties may be associated with construction?	No construction or operation.	Construction techniques are standard practice. Solidifying the subsurface to minimize subsidence will be moderately difficult.	Few difficulties are expected. Technology implementation has been extensively researched to define site-specific requirements. The need to control potential contamination spread from the drill string will pose moderate difficulty.	Specialized equipment with site-specific design criteria is required. Additional treatability testing is needed to address contamination control, pretreatment, and worker protection issues.	Potential variability in waste materials and contaminant characteristics will require specialized equipment with site-specific design criteria.
What uncertainties are related to construction?	No construction or operation	Standard earthwork practices. The subgrade stabilization process (jet grouting) has not been tested to verify site-specific application requirements.	Potential for interference from certain types of waste may limit areas that grouting can be applied. Of particular concern is the high nitrate-concentrated waste in Pad A.	The site-specific design requirements for safety components have not yet been derived.	Waste stream variability and potential implications to contamination control, worker protection, treatment, and waste handling requirements. The availability of a future disposal site of adequate capacity for the TRU waste is uncertain.
What is the likelihood that technical problems will lead to schedule delays?	No construction or operation	Standard earthwork operation. However, problems encountered with stabilizing the subgrade could lead to schedule delays.	The technology uses relatively few pieces of equipment, each of which are commonly used in construction work. The contamination control system (e.g., seals, bags, ventilation) may contribute to some delays, as its reliability is unknown.	Because of the uncertainties related to the design and operation of the technology, implementation issues associated with the variability of the SDA waste and specific contamination control requirements could lead to schedule delays.	The likelihood for schedule delays is great, considering the number of systems and components and the first-of-a-kind nature of the retrieval and treatment facilities.

Table C-1. (continued).

Evaluation Criterion and Analysis Factors	Alternative #1 No Action	Alternative #2 Surface Barrier	Alternative #3 In Situ Grouting	Alternative #4 In Situ Vitrification	Alternative #5 Retrieval, Treatment, and Disposal
What likely future remedial actions may be anticipated?	Five-year reviews may show cause for additional action. Such actions may require a second feasibility study to evaluate actions, including containment, treatment, or removal. Further migration of contaminants to adjacent media should be anticipated and potentially increasing any future remediation requirements associated with the SDA waste.	Risk modeling has shown that this alternative will be protective, and, if properly implemented, additional remedial measures are not anticipated. Long-term maintenance and periodic repair of the cap will be required.	Risk modeling has shown that this alternative will be protective (if properly implemented), and additional remedial measures are not anticipated. The long-term durability of the grouted waste will need to be verified. Long-term maintenance and periodic repair of the cap will be required.	Risk modeling has shown that this alternative will be protective (if properly implemented), and additional remedial measures are not anticipated. The ISV produces a stable, high-quality waste form. Additional remedial measures are not anticipated. Long-term maintenance and periodic repair of the cap will be required.	Risk modeling has shown that this alternative will be protective (if properly implemented), and additional remedial measures are not anticipated. Long-term maintenance and periodic repair of the cap will be required.
How difficult would it be to implement the additional remedial actions, if required?	The no action alternative would not preclude or inhibit future action, if required.	Additional actions would require the full or partial removal of the surface barrier.	The ease of additional actions depends on the type of grout used. Several candidate grouts, for example, are "soft" and may aid future retrievals by minimizing contamination spread. Other grouts are rock hard and would preclude conventional excavation. The presence of a multilayer cover also would be a hindrance.	Very difficult, due to the size and hardness of the resultant monolith.	Additional actions would not be difficult. The presence of a multilayer cover would be the greatest hindrance.
Do migration or exposure pathways exist that cannot be monitored adequately?	Migration and exposure pathways are easily monitored under this alternative.	Migration and exposure pathways are easily monitored under this alternative.	Migration and exposure pathways are easily monitored under this alternative.	Migration and exposure pathways are easily monitored under this alternative.	Migration and exposure pathways are easily monitored under this alternative.
What risks of exposure exist should monitoring be insufficient to detect failure?	Exposure risks would be equal to those identified in the IRA.	If portions of the surface barrier fail, impacts to downgradient groundwater could occur.	If portions of the grout failed to adequately reduce contaminant leaching, the resulting risks to groundwater would be less than or equal to the risks calculated in the BRA. The most likely failure is that a small area was not completely grouted.	If portions of the vitrification failed to adequately reduce contaminant leaching, the resulting exposure risks would be less than or equal to the risks calculated in the BRA. The most likely failure is that a small area was not completely vitrified.	During the remedial action, the risks of exposure are great, should monitoring be insufficient to detect failure. Over the long-term, the risk of exposure is significantly reduced as the majority of contaminants are removed from the site.
Administrative feasibility					
What steps are required to coordinate with other agencies?	This alternative will not require additional permitting with other agencies.	This alternative will not require additional permitting with other agencies.	This alternative will not require additional permitting with other agencies.	Off-gas treatment requirements, processes, and systems will be negotiated with the IDEQ and EPA. The issue of air emissions may require further coordination with other public organizations.	Transportation, air emissions, and disposal issues would have to be coordinated with multiple agencies across multiple states.
What steps are required to set up long-term or future coordination among agencies?	A long-term institutional control plan would have to be negotiated with the regulatory agencies to continue monitoring.	A long-term institutional control plan would have to be negotiated with the regulatory agencies to continue monitoring and restrict future land use.	A long-term institutional control plan would have to be negotiated with the regulatory agencies to continue monitoring and restrict future land use.	A long-term institutional control plan would have to be negotiated with the regulatory agencies to continue monitoring and restrict future land use.	A long-term institutional control plan would have to be negotiated with the regulatory agencies to continue monitoring and restrict future land use.
Can permits for off-Site activities be obtained if required?	There would be no off-Site activities under this alternative.	There would be no off-Site activities under this alternative.	There would be no off-Site activities under this alternative.	There would be no off-Site activities under this alternative.	It is anticipated that permits for off-Site disposal could be obtained.

Table C-1. (continued).

Evaluation Criterion and Analysis Factors	Alternative #1 No Action	Alternative #2 Surface Barrier	Alternative #3 In Situ Grouting	Alternative #4 In Situ Vitrification	Alternative #5 Retrieval, Treatment, and Disposal
Availability of services and materials					
Are adequate treatment, storage capacity, and disposal services available?	Treatment, storage, and disposal services are not needed.	Adequate construction and ISG equipment are available.	Adequate construction and ISG equipment are available.	Limited ISV equipment is currently available.	The availability of disposal facilities of sufficient capacity for the disposal of TRU waste is questionable.
How much additional capacity is necessary?	Not applicable.	Not applicable	Not applicable.	Additional ISV equipment would have to be manufactured to implement the alternative.	Site-specific retrieval, waste handling, and treatment equipment will have to be manufactured. The predicted volume of TRU waste within the SDA that would be retrieved and disposed of exceeds the entire capacity of WIPP.
Does the lack of capacity prevent implementation?	Not applicable.	No	No.	No	The lack of available off-Site disposal capacity for TRU could prevent implementation of alternative.
What additional provisions are required to ensure the needed additional capacity?	Not applicable.	Not applicable	Not applicable.	Not applicable	Documentation and coordination with WIPP to generate increased capacity as required to accommodate predicted SDA TRU waste.
Are necessary equipment and specialists available?	Not applicable	Necessary equipment and specialists are available or can be transported to the site	Necessary equipment and specialists are available from qualified vendors.	Specialists and services are very limited Necessary equipment may have to be designed and constructed.	Necessary equipment would have to be designed, fabricated, and tested. Specialists would have to be trained.
What additional equipment and specialists are required?	Not applicable.	None.	None.	Off-gas treatment systems would have to be designed and built.	Confinement systems, fissile material monitors, etc.
Does the lack of equipment and specialists prevent implementation?	Not applicable.	No.	No	It is anticipated that the necessary equipment can be designed and fabricated and specialists trained during an extended design and action phase.	It is anticipated that the necessary equipment can be designed and fabricated and specialists trained during an extended design and action phase.
What additional provisions are required to ensure the needed equipment and specialists?	Not applicable.	None	None	Testing and design of the planar ISV technology should be conducted to identify site-specific requirements.	Continued investigation of characterization and treatment processes.
Are technologies under consideration generally available and sufficiently demonstrated for the specific application?	Not applicable.	The necessary technologies are available and sufficiently demonstrated.	The technologies are available commercially from multiple vendors. The technology has been demonstrated at the INEEL.	The necessary technology is available from one commercial firm. The technology is not sufficiently demonstrated for the specific application in SDA waste.	Technologies under consideration are generally available. However, site-specific applications have not been demonstrated.
Will technologies require further development before they can be applied full-scale to the type of waste at the site?	Not applicable.	No specialized technologies are required for the surface barrier construction. Additional development and testing of contamination control systems may be required for the pretreatment activity.	Prototype ISG equipment has already been tested at the INEEL. Additional testing is required to complete the safety analysis and remedial design.	Substantial analysis, design, and testing will be required before full-scale application. Additional testing is required to complete the safety analysis and remedial design.	Equipment for real-time monitoring for fissile mass may not be immediately available. Remotely operated excavation techniques, if used, may require additional development. Nondestructive assay equipment for waste bins requires development. Large-scale confinement systems to mitigate airborne alpha contamination may require development.

Table C-1. (continued).

Evaluation Criterion and Analysis Factors	Alternative #1 No Action	Alternative #2 Surface Barrier	Alternative #3 In Situ Grouting	Alternative #4 In Situ Vitrification	Alternative #5 Retrieval, Treatment, and Disposal
When should the technology be available for full-scale use?	Not applicable	No specialized technologies are required.	Prototype equipment has already been tested at the INEEL.	Uncertain. Technology-specific application requirements need to determined.	Uncertain. Extensive research required to define detailed technology requirements.
Will more than one vendor be available to provide a competitive bid?	Multiple vendors are available for all aspects of the work.	Multiple vendors are available for all aspects of the work.	Multiple vendors are available for all aspects of the work.	Uncertain	Multiple vendors are available to provide most components. However, it is uncertain whether vendors are available to provide an integrated system and service.
Cost					
Capital Cost (FY-02 $)	0	270,350,000	1,576,560,000	2,166,320,000	6,725,680,000
O&M Cost (FY-02 $)	38,810,000	87,440,000	57,520,000	57,600,000	54,120,000
Net Present Value	5,540,000	160,940,000	776,370,000	951,650,000	2,324,160,000

ARAR = applicable or relevant and appropriate requirement
BRA = baseline risk assessment
COC = contaminant of concern
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
ICDF = INEEL CERCLA Disposal Facility
IDEQ = Idaho Department of Environmental Quality
INEEL = Idaho National Engineering and Environmental Laboratory
IRA = Interim Risk Assessment
ISG = in situ grouting
ISTD = in situ thermal desorption
ISV = in situ vitrification
LDR = land disposal restriction
LLW = low-level waste
MEE = melt expulsion event
MLLW = mixed low-level waste
O&M = operations and maintenance
PPE = personal protective equipment
PRG = preliminary remediation goal
RAO = remedial action objective
ROD = Record of Decision
SDA = Subsurface Disposal Area
SVR = soil vault row
TRU = transuranic
WAC = waste acceptance criteria
WIPP = Waste Isolation Pilot Plant